

Digital Twins Webinar Summary

Webinar Date	February 16, 2022
Webinar Time	13:00 to 16:00 CET
Chair	Louise Theodon/Erika Holt
Prepared by	Tim Schatz

Background

The EURAD and PREDIS projects jointly hosted an informational webinar (*Digital Twins in Radioactive Waste Management*) on February 16, 2022. Digitalization in general and digital twin technology specifically are areas of growing interest in the radioactive waste sector, most visibly in decommissioning. This webinar was aimed at showcasing digital twin applications and further establishing connections between outcomes from the EURAD and PREDIS projects and digital twin technology.

The content (see Appendix 1 for agenda) of this webinar is summarised below:

- István Szőke (IFE) gave a presentation on needs, examples and opportunities for digital twin technology in the nuclear back-end. The nuclear sector presents a set of unique challenges such as performing safety critical processes under strict qualification requirements, dealing with specific nuclear/radiological hazards and associated data types, models and sensors and the encompassing difficulty to introduce new technologies due to the previous factors. Digital twin technologies are being developed and used for visualizing, optimizing and supporting work processes in radiologically hazardous environments, building BIM-type decommissioning tools and integrating robotics for 3D and radiological mapping.
- Dan Miron (PSI) discussed the current work of the PREDIS project with respect to digital twin technology. The PREDIS digital twin is aimed at predicting years-long evolution of radioactive waste packages under different scenarios. This tool uses geochemical and chemo-mechanical models (and their respective input) to generate output (gas production, volume expansion, container corrosion) relevant for waste package considerations. Ultimately, the tool will be applicable to a wide range of waste packages and should find use in evaluating the state of legacy wastes and designing future waste forms.
- Francis Claret (BRGM), Diederik Jacques (SCK CEN), Markus Olin (VTT), Johan Bertrand (ANDRA) and Sergey Churakov (PSI) briefly summarized the EURAD projects DONUT (on numerical modelling of coupled processes), ACED (on the chemical evolution of disposal cells), HITEC (on the influence of high temperature on clay behavior), MODATS (on repository monitoring) and FUTURE (on radionuclide retention), respectively, and the possible connections of these research areas to digital twin technology.
- Dag Fjeld Edvardsen (Catenda) described and demonstrated an open, interoperable BIM platform, aimed at the construction industry, which provides 2D and 3D visualization of architectural models, structural models, mechanical models, electrical models and technology models and enables integration with VR, AR and MR and intelligent, decision-support applications. The critical importance of forming a standardized, common data environment to these ends was repeatedly stressed.
- Katja Sipilä (SWECO) further discussed the advantages of 3D visualization and processing for optioneering and optimizing construction projects. 360-degree images, point clouds, engineering drawings, material specifications and personnel knowledge can all serve as input to BIM (or

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Inventory Twin) models. Nuclear facilities are challenging from a decommissioning perspective in that, given the age of the structures, much of the design information is missing or unreliable. The ongoing decommissioning of the VTT FIR1 research reactor was used as an example.

- Arnaud Duchene (Tractebel) reviewed digital twins in support of dismantling and decommissioning projects. Specific objectives for digital twins in this area are creating digital models of plant inventories, predicting and optimizing waste quantities and dismantling schedules, representing and simulating contamination and activation data and system engineering. To be most effective, digital twins in the nuclear sector will process complex simulations, deal with decentralized and unstructured data and handle limitations imposed by confidentiality and accessibility rules.
- Guillaume Pepin (ANDRA) presented the work ongoing at ANDRA towards full digitalization of the Cigéo GDF. Objectives of this work include building a 3D digital model of the repository as an operational tool and creating a 4D multi-spatial, multi-physical, multi-component digital twin representation of simulated and measured data. Specific examples such as integrating thermal evolution of HLW disposal cells, using machine learning to reconstruct missing sensor data and employing virtual reality for accident scenario training were displayed.

The presentations are available on the PREDIS website (<https://predis-h2020.eu/digital-twins-in-radioactive-waste-management/>).

Following the formal presentation sessions, a set of small group discussions were held. Attendees were randomly assigned to 1 of 4 moderated breakout rooms. The aim of the 30-minute discussion session was to gather perspectives framed around the following questions (although discussions were not limited):

- What are the opportunities for digital twin technology in the radioactive waste domain?
- What are the challenges for adoption of digital twin technology?
- How can EURAD/PREDIS best assist successful deployment of digital twin technology?

In all, 150 participants registered to attend the webinar. Representation was divided between PREDIS end user group members + general stakeholders and consortium partners at 73% to 27%. A total of 147 people joined the webinar over its duration.

Outcomes

Some key takeaways from the deliberations of the discussion sessions were as follows:

Opportunities

- ☐ Digital twins in waste package acceptance procedures: demonstrating the viability of waste forms, designing conditioning waste forms (with AI and ML techniques).
- ☐ Digital twins as tools for knowledge management (e.g., preservation, visualization and interaction with institutional knowledge).
- ☐ Digital twins as a means for stakeholder communication (authorities, management, general public).
- ☐ Digital twins in facility design and development to understand and differentiate when previous features and information can be reused (or where adaptation is required) and reduce testing and demonstration needs.

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Challenges

- ▣ Waste package evolution is very slow, and the complexity of involved processes/models and their coupling is very high.
- ▣ Validation of simulation results is difficult.
- ▣ Implementing fast, simplified surrogate models trained by data sets from numerical models.
- ▣ Modular development; building the complete twin by combining sub-processes.
- ▣ Careful deployment with sensors and monitoring strategies that enable real time update of the digital twin; requires appropriate design of sensors to measure the right parameters.
- ▣ Overcoming barriers to acceptance of advanced technologies in safety critical processes; harmonization of standards.
- ▣ Understand what is wanted from the digital twin, what it can actually offer and at what cost.
- ▣ Digital twin doesn't mean identical twin.

Assistance

- ▣ Sensor development.
- ▣ Involving digital twins in KM activities.
- ▣ Networking and exchange with regard to digital twin development.
- ▣ Strategic study on best practices: what are the strengths and weaknesses of digital twin technology, where are applications in predisposal management similar to applications in other industries, where are they different and how to utilize this information?

Live-polling indicated (see Appendix 2 for all live-polling results):

The majority of respondents registered for the characterisation webinar to increase their general knowledge.

The majority of respondents indicated that digital twin could provide the most impact in radioactive waste management through supporting decision making, increasing operating efficiencies and improving safety (in that order).

Overall, the level of interest and satisfaction with the digital twins webinar was favorable. The webinar had a high retention rate (> 64%) to its close. Analyses of participant responses to a post-webinar survey also indicated a good level of satisfaction (average overall score of 4.5/5.0). Participants also reflected that it would be valuable to include time to ask questions of the presenters directly.



Digital Twins in Radioactive Waste Management

Free webinar on 16 February 2022, 13-16 CET

Agenda:

13:00 to 15:20 Presentations

13:00-13:15 Welcome & Introduction (Erika Holt, VTT and Louise Theodon, ANDRA)

13:15-13:30 Examples and opportunities for digital twins in the nuclear back-end (István Szőke, IFE)

13:30-13:45 Digital twins in PREDIS (Dan Miron, PSI)

13:45-14:05 Digital twins in EURAD

- DONUT on numerical modelling of coupled processes (Francis Claret, BRGM)
- ACED on chemical evolution of disposal cells (Diederik Jacques, SCK CEN)
- HITEC on influence of high temperature on clay behaviour (Markus Olin, VTT)
- MODATS on repository monitoring (Johan Bertrand, ANDRA)
- FUTURE on radionuclide retention (Sergey Churakov, PSI)

14:05-14:10 break

14:10-14:25 Digital twins in construction (Dag Fjeld Edvardsen, Catenda)

14:25-14:40 Using inventory twins to enable virtual planning of decommissioning (Katja Sipilä, Sweco)

14:40-14:55 Digital twins in support of dismantling projects (Arnaud Duchene, Tractebel)

14:55-15:10 From BIM towards a 4D digital twin of Cigeo repository in support of the operational phase: issues, needs and work in progress (Guillaume Pepin, ANDRA)

15:10-15:20 break

15:20 to 15:50 Breakout Room Discussions

- What are the opportunities for digital twin technology in the radioactive waste domain?
- What are the challenges for adoption of digital twin technology?
- How can EURAD/PREDIS best assist successful deployment of digital twin technology?

15:50 to 16:00 Close

15:50-16:00 Feedback from breakout rooms / Summary and Conclusions

16:00 Adjourn



The EURAD programme has received funding from the European Union's Horizon 2020 research and innovation programme 2014-2018 under grant agreement n°847593.

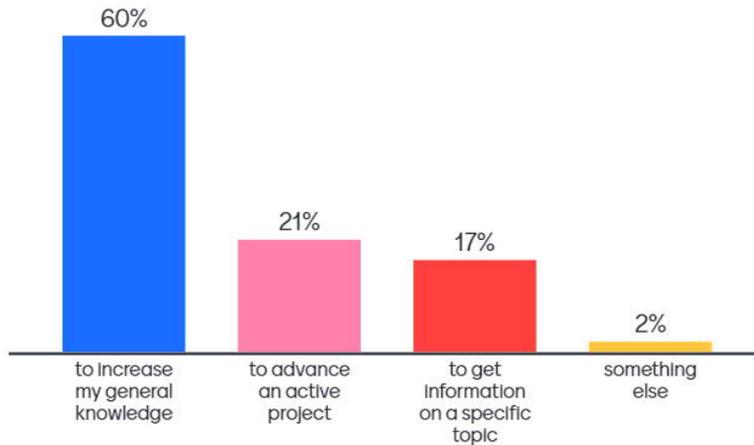
The PREDIS project has received funding from the EURATOM research and training programme 2019-2020 under grant agreement

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Appendix 2. Live-Polling Results

Why did you register for this webinar?

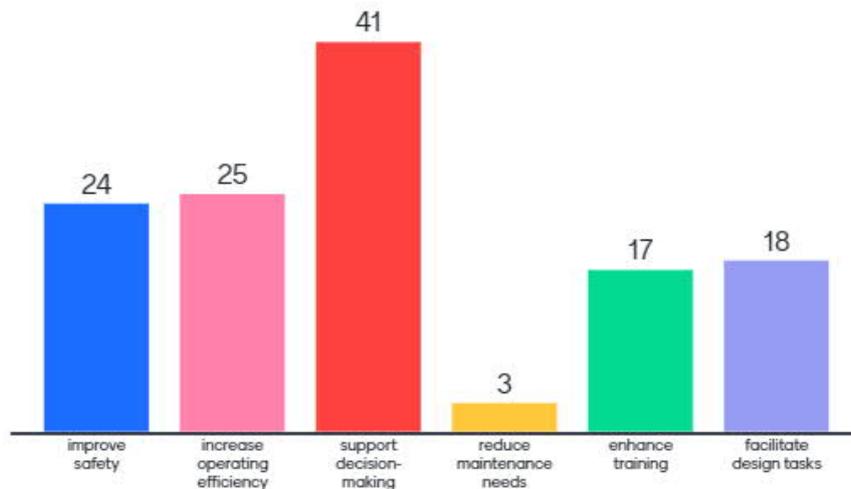
Mentimeter



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Where do you think digital twins could provide the most impact in radioactive waste management? (select up to three options)

Mentimeter



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